Northwest Atlantic Fisheries Organization

Serial No. N4086 **NAFO SCR Doc. 99/30**

SCIENTIFIC COUNCIL MEETING – JUNE 1999

Survey for Greenland Halibut in NAFO DivisionS 1C-1D, 1998

by

O.A. Jørgensen

Greenland Institute of Natural Resources
Pilestræde 52, DK1016 Copenhagen, Denmark

Abstract

In 1997 Greenland initiated a survey series covering NAFO Div. 1CD at depths between 400 and 1500 m. The survey is designed as a Stratified Random Bottom Trawl Survey mainly aimed at Greenland halibut and roundnose grenadier. In 1998 56 tows were made. The paper gives biomass estimates, abundance estimates and length frequencies for Greenland halibut, roundnose grenadier, roughhead grenadier, deep-sea redfish, and American place, together with age and maturity data for Greenland halibut. The biomass of Greenland halibut increased from 56 000 tons in 1997 to 70 000 in 1998. The biomass of roundnose grenadier also increased slightly, but is still at a very low level compared to the late 1980s.

Introduction

During the period 1987-1995 Japan Marine Fishery Resources Research Center (JAMARC) and Greenland Institute of Natural Resources jointly conducted 12 bottom trawl surveys (Jørgensen 1999) and 4 pelagic surveys (Jørgensen 1997a) at West Greenland as part of a joint venture agreement on fisheries development and fisheries research in Greenland waters. The bottom trawl surveys were primarily aimed at Greenland halibut (*Reinhardtius hippoglossoides*) in NAFO Div. 1B-1D. In 1997 Greenland Institute of Natural Resources continued the bottom trawl surveys series with the Institute's own vessel PAAMIUT which had been rigged for deep sea trawling. There has unfortunately not been any comparative trawlings between the Japanese research vessel SHINKAI MARU and PAAMIUT making comparisons between the surveys difficult.

Materials and Methods

The survey in 1998 took place in the period 23/9-7/10.

Stratification

The survey covered NAFO Div. 1C and 1D between the 3-nm line and the 200-nm line or the midline to Canada at depths between 400 and 1500 m. (Most of the joint Greenland/Japan surveys also covered Div.1B. This area is, however, covered down to 600 m by the Greenland Shrimp Survey and the area of depths > 600 m in Div. 1B is small). The survey area was stratified in NAFO Divisions and subdivided in 6 depth strata: 401-600, 601-800, 801-1000, 1001-1200, 1201-1400 and 1401-1500 m. The depth stratification was mainly based on Greenland Geological Survey's 10 m depth contour maps. These maps do not cover the western part of the survey area, but here a Canadian map and depth soundings made under previous surveys were used. The area of each stratum was measured using "Mapinfo Version 4.0"(Table 1).

The survey was planned as a Stratified Random Bottom Trawl Survey with in total 75 hauls (5 hauls a day in 15 days). Basically hauls were allocated proportional to stratum area. Analysis of the joint Greenland/Japan survey data and the survey in 1997 showed that Div. 1C depth stratum 601-800 m traditionally had been oversamplet, while depth stratum 1001-1200 m and 1201-1400 m in Div. 1D had been undersamplet. More hauls were, hence, allocated to the two latter strata, than their area justified, in order to reduce the variance of the estimated biomass and abundance of Greenland halibut. The positions of the hauls were selected at random within each stratum.

Vessel and gear

The survey was conducted by the 722 GRT trawler PAAMIUT, using an ALFREDO III trawl with a mesh size on 140 mm and a 30-mm mesh-liner in the cod-end. The ground gear was of the rock hopper type. The trawl doors were Greenland Perfect (370*250 cm) weighing 2400 kg mounted with extra 20 kg. Further information about trawl and gear is given in Jørgensen 1998. A Furuno net sonde mounted on the head rope measured net height. Scanmar sensors measured the distance between the trawl doors. Wingspread, taken as the distance between the outer bobbins, was calculated as:

distance between outer bobbins=10.122 + distance between trawl doors * 0.142

This relationship was estimated based on flume tank measurements of the trawl and rigging used in the survey (Jørgensen 1998).

Trawling procedure

Towing time was usually 30 min, but towing times down to 15 min were accepted. Average towing speed was 3.0 kn. Towing speed was estimated from the start and end positions of the haul. Trawling took place in daytime only (7 a.m. to 7 p.m. local time, 9 to 21 UTC).

Otoliths for age determination of Greenland halibut (n=574) were soaked in water and read in transparent light. The age length-key included otoliths sampled in Div. 1B-1D during a presiding shrimp trawl survey, but there was no difference in the mean age-at-length and -weight in the two surveys and data were pooled. Age distributions were estimated using age/length keys and survey length frequencies pooled in 3-cm groups.

Near-bottom temperatures were measured, by 0.1 ^{o}C, by a Seamon sensor mounted on a trawl door.

Handling of the catch

After each haul the catch was sorted by species and weighed to nearest 0.1 kg, and the number of specimens recorded. Most fish species were sexed and measured as total length (TL) to 1.0 cm below. Grenadiers were measured as pre anal fin length (AFL) to 0.5 cm below. In case of large catches subsamples of the catch were measured, subsamples comprised always of at least 200 specimens.

Biomass and abundance estimates were obtained by applying the swept area method (estimated trawling speed * estimated bobbin spread) taking the catchability coefficient as 1.0. All catches were standardised to 1 km swept.

Results and Discussion

In total 56 successful hauls were made, giving a mean coverage of 934 km^2 per haul (Table 1). The number of tows was reduced compared to the 75 planned due to bad weather.

Greenland halibut (*Reinhardtius hippoglossoides*).

Greenland halibut was caught in all hauls and the catches ranged between 2.2 kg at 500 m in Div. 1C and 921.1 kg at 1292 m in Div. 1D (Fig. 1, Table 2).

The biomass of Greenland halibut in Div. 1C-1D, 401-1500 m, was estimated at 70473.5 tons (S.E. 8391.7) which is an (statistically insignificant 95% level) increase compared to 56260.2 tons (S.E. 4399.6) in 1997 (Jørgensen 1998).

The highest densities were found at depths between 1000 and 1400 m (Table 3). The increase in biomass was seen in all strata except the shallow stratum in 1C and 1D, where the biomass is very low, and in the deepest stratum, 1401-1500 m in Div. 1D.

The abundance in Div. 1C-1D was estimated at $67.677*10^6$ (S.E. $7.687*10^6$) compared to $53.613*10^6$ (S.E. $4.118*10^6$) in 1997. The highest concentrations were found at depths 1001-1400 m in Div. 1C and 1D. (Table 4)

The length ranged from 12 cm to 103 cm. Generally the length distributions in the different depth strata were dominated by a single mode, except in Div. 1C depth stratum 601-800 m. Fish size increased with depth and from north to south at the same depth (Fig. 2) as seen in previous surveys (Jørgensen 1997b, 1998). The overall length distribution (weighted by stratum area) was dominated by a mode around 48 where the mode was at around 50 in 1997 (Fig. 3)

The age ranged from 2 to 19 years with the youngest fish in shallow water in Div. 1C and the oldest fish in deep water in Div. 1D (Fig. 4). Generally the age increased by depth and there was a tendency towards an increase in age from north to south at the same depth. At 401-600 m the ages 3-4 dominated. At depths between 601 and 1000 m the ages 5-6 were dominating, while the ages 6-8 dominated at deeper waters. The overall age distribution (weighted by stratum area) was monomodal with a mode around age 6 (Fig. 5). The length distributions in the surveys have always been very similar (Jørgensen 1998, 1999), but the mode in the agedistributions has ranged between 6, 7 and 8 (Table 5). This suggests a systematic difference in the interpretation of the otoliths by the three age readers engaged in age readings in resent years. The difference is especially pronounced between the reader of the 1997 otoliths and the reader before and after, while there seems to be a better agreement between the reader of the 1995-1996 reader and the 1998 reader. The age composition should therefore be interpreted with caution. When applying the age length key from the 1998 survey on the 1997 length distribution, the age distribution in the two surveys is very similar (Fig. 5 and 6).

The estimated abundance by age is given in Table 6.

Females stated maturing at age 7 and 50 % of the females were mature between age 8 and 9 and 100% maturity was reached at age 14 (Table 7).

Roundnose grenadier (*Coryphaenoides rupestris*)

Roundnose grenadier was caught in 46 of the 56 hauls, but the catches were generally low, ranging from 0.1 kg in several hauls to 282.7 kg at 1292 m depths in Div. 1D. (Fig. 7, Table 2).

The biomass of roundnose grenadier in Div. 1C-1D, 401-1500 m, was estimated at 7263.3 tons (S.E. 2530.2) which is an small increase compared to 1997 (5686.5 tons, S.E. 926.4) (Jørgensen 1998). The biomass is, however, still at the low level observed since 1993 (Jørgensen 1998, 1999).
Most of the biomass was found in Div. 1D at depths > 1000 m (Table 8), but Div. 1C 801-1000 m contributed with 1000 tons, while almost no biomas was found in that area in 1997.

The abundance in Div. 1C-1D was estimated at $75.243*10^6$ (S.E. $27.357*10^6$) compared to $32.441*10^6$ (S.E. $7.056*10^6$) in 1997. The highest concentration was found in depth stratum 1201-1400 m in Div. 1D and in Div. 1C 801-1000 m. (Table 9). The doubling of the abundance was caused by a large number of small fish in Div. 1C 601-1000 m where the abundance increased from about $2*10^6$ about $35*10^6$.

Pre anal fin length ranged from 1.0 to cm 20 cm. Generally the length distributions in the different depth strata were dominated by a single mode. Fish size increased generally with increasing depth, but the fish were generally smaller compared to 1997 (Fig. 8), where the overall length distribution (weighted by stratum area) was dominated by a mode around 8 cm. In 1998 the mode was between 4 and 8 cm and there were almost no fish above 8 cm (Fig. 9).

Roughhead grenadier (*Macrourus berglax*)

Roughhead grenadier was caught in 54 of the 56 hauls, but the catches were low, ranging from 0.1 kg to 18.0 kg, with the largest catches in Div. 1D at depths between 1000 and 1400 m (Fig.10, Table 2).

The biomass of roughhead grenadier in Div. 1C-1D, 401-1500 m, was estimated at 4314.1 tons (S.E. 377.9) compared to 2258.6 tons (S.E. 250.1) in 1997. Most of the biomass was found in Div. 1D at depths between 801 and 1400 m, but also Div. 1C depth strata 601-1000 m contributed significantly (Table 10). The abundance in Div. 1C-1D was estimated at $11.623*10^6$ (S.E. $1.008*10^6$) compared to $4.60*10^6$ (S.E. $0.45*10^6$) in 1997 (Table 11).

Pre anal fin length ranged from 2.0 to cm 45 cm. The overall length distribution (weighted by stratum area) was dominated by modes at 11 and 14 cm (Fig. 11).

Deep sea redfish (*Sebastes mentella*)

Deep-sea redfish was caught in 26 the 56 hauls, but the catches were low, ranging from 0.1 kg to 36.2 kg. (Fig. 12, Table 2).

The biomass of deep-sea redfish in Div. 1C-1D, 401-1500 m, was estimated at 2408.1 tons (S.E. 503.9) compared to 2464.3 tons (S.E. 787.1) in 1997. Almost all the biomass was found in at depths < 800 m, mainly in Div. 1C (Table 12).

The abundance in Div. 1C-1D was estimated at $18.827 *10^6$ (S.E. $4.496*10^6$) compared to $14.69*10^6$ (S.E. $5.50*10^6$) in 1997 (Table 13).

The overall length distribution ranged from 13 to 44 cm and was dominated by a mode at 25 cm (Fig. 13).

American place (*Hippoglossoides platessoides*).

American place was caught in 8 of the 56 hauls, and the catches were low, ranging from < 0.1 kg to 3.9 kg (Table 2).

The biomass of American place in Div. 1C-1D, 401-1500 m, was estimated at 136.6 tons (S.E. 56.0) compared to 137.1 tons (S.E. 26.7) in 1997. Almost all the biomass was found at depths < 600 m, mainly in Div. 1C (Table 14). The abundance in Div. 1C-1D was estimated at $1.280*10^6$ (S.E. $0.637*10^6$) compared to $0.83*10^6$ (S.E. $8.11*10^4$) in 1997 (Table 15).

Temperature

The bottom temperature ranged from 2.2 C in depth stratum 601-800 m in Div. 1C to 5.3 C in depth stratum 401-600 m in Div. 1C (Table 2). Mean temperatures by NAFO Div. and depth strata are given in Table 16.

References

Jørgensen, O A. 1997b. Movement patterns of Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum.) at West Greenland, as inferred from Trawl Survey Distribution and Size Data.. *J. Northw. Atl. Fish. Sci*.; **21**:23-37.

Jørgensen, O A. 1997a. Pelagic occurrence of Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum) in West Greenland waters. *J. Northw. Atl. Fish. Sci*.; **21**:39-50.

Jørgensen O.A. 1998. Survey for Greenland Halibut in NAFO Division 1C-1D, 1998. NAFO SCR Doc. 98/28. Serial No. N3010, 26 pp.

Jørgensen O. A. 1999. Results of the Joint Japan Greenland Trawl Surveys at West Greenland 1987-1995 on Greenland Halibut (*Reinhardtius hippoglossoides*) and Roundnose Grenadier (*Coryphaenoides rupestris*). *NAFO Sci. Council Studies* No 31. 1-36. In Press

Table 1. Area (sq. km) of depth strata by NAFO Division and number of hauls planned ( ) conducted.

Div.	Depth stratum (m)						Tot.
	401-600	601-800	801-1000	1001-1200	1201-1400	1401-1500	
1C	3366 (5) 4	16120 (14) 14	6066 (8) 8	611 (2) 2	-	-	26163 (29) 28
1D	903 (2) 1	1940 (3) 2	3874 (5) 4	10140 (19) 11	6195 (12) 8	3091 (5) 2	26143 (46) 28
Tot	4269 (5)	18060 (16)	9940 (13) 12	10751 (21) 13	6195 (12) 8	3091 (5) 2	52306 (75) 56

Table 2. Catch weight and number (not standardised to kg/km^2) of Greenland halibut, roundnose and roughhead grenadier, Sebastes mentella and American place by haul. Depth in m, swept area in km^2 and bottom temperature in C.

								Greenland halibut		Roundnose grenadier		Roughhead grenadier		Sebastes mentella		American plaice	
Stat. No	Month	Day	Depth	SWEPAREA	Div.	Stra..	Temp.	Number	Kg	Number	Kg	Number	Kg	Number	Kg	Number	Kg
1	9	23	725.0	0.05310	1C	8	4.1	9	5.6	134	4.3	9	2.7	21	9.9	0	0.0
2	9	23	584.5	0.05530	1C	6	4.9	6	3.5	3	0.1	2	0.9	85	13.7	44	3.9
3	9	23	573.5	0.06711	1C	6	5.1	6	4.4	0	0.0	1	0.6	187	26.2	6	1.1
4	9	23	681.5	0.07965	1C	8	4.3	12	5.3	1	0.1	4	1.0	254	0.0	6	0.7
5	9	24	517.5	0.06798	1C	6	4.8	16	9.7	0	0.0	0	0.0	299	22.3	3	0.2
6	9	24	670.5	0.08213	1C	8	2.2	159	71.3	0	0.0	5	0.9	6	0.4	0	0.0
7	9	25	666.0	0.08246	1C	8	2.3	63	22.2	0	0.0	6	0.6	19	2.1	0	0.0
8	9	25	631.5	0.07337	1C	8	2.2	49	24.2	0	0.0	4	0.3	28	3.4	0	0.0
9	9	25	698.0	0.07664	1C	8	3.5	50	24.0	0	0.0	5	2.7	11	1.8	0	0.0
10	9	25	793.0	0.08604	1C	8	3.9	65	58.6	38	1.7	19	5.6	1	0.2	0	0.0
11	9	26	773.5	0.08561	1C	8	4.3	17	15.4	99	2.9	16	2.9	12	3.5	0	0.0
12	9	26	872.5	0.06060	1C	10	4.0	121	107.2	193	7.2	21	7.6	1	0.3	0	0.0
13	9	26	852.5	0.08368	1C	10	3.7	67	48.0	139	3.7	31	6.6	0	0.0	0	0.0
14	9	26	499.5	0.07142	1C	6	5.3	4	2.2	0	0.0	0	0.0	54	7.9	2	0.4
15	9	26	746.0	0.03926	1C	8	4.4	42	23.8	327	7.9	12	2.8	37	15.1	2	0.5
16	9	26	942.0	0.06574	1C	10	4.0	316	241.6	1319	66.5	13	5.3	1	0.2	0	0.0
17	9	26	1094.0	0.07861	1C	12	3.5	268	273.5	128	9.0	29	10.0	0	0.0	0	0.0
18	9	27	986.5	0.08259	1D	10	3.5	174	161.3	28	1.1	23	8.6	0	0.0	0	0.0
19	9	27	1051.5	0.07227	1C	12	3.5	295	284.4	95	4.4	31	10.6	0	0.0	0	0.0
20	9	27	973.5	0.08205	1C	10	3.6	202	187.5	112	5.6	45	17.4	0	0.0	0	0.0
21	9	28	773.0	0.07716	1C	8	3.9	42	29.6	3	0.2	41	11.5	2	0.4	0	0.0
22	9	28	733.5	0.07118	1C	8	3.7	24	14.8	0	0.0	4	1.0	6	1.2	0	0.0
23	9	28	820.0	0.08217	1C	10	3.8	44	33.7	1	0.0	29	5.5	0	0.0	0	0.0
24	9	28	763.0	0.08641	1C	8	3.8	40	25.7	0	0.0	7	1.6	1	0.1	0	0.0
25	9	28	713.5	0.08175	1C	8	3.7	53	24.6	1	0.0	8	2.3	14	2.4	0	0.0
26	9	29	774.5	0.07411	1C	8	3.9	66	67.2	0	0.0	9	1.0	1	0.7	1	0.0
27	9	29	843.0	0.07182	1C	10	3.9	83	64.3	8	0.3	15	3.4	0	0.0	0	0.0
28	9	29	834.0	0.07828	1C	10	3.9	77	58.0	3	0.1	13	4.5	0	0.0	0	0.0
29	9	29	874.0	0.07901	1C	10	3.8	82	71.8	8	0.6	35	10.8	0	0.0	0	0.0
30	9	29	763.5	0.07620	1D	8	3.8	33	26.3	9	0.6	39	13.1	6	1.4	0	0.0
31	9	30	681.5	0.04813	1D	8	3.7	27	20.4	9	0.3	18	3.8	18	4.1	0	0.0
32	9	30	905.5	0.08137	1D	10	3.5	70	60.9	17	0.6	14	4.1	0	0.0	0	0.0
33	9	30	1088.0	0.07942	1D	12	3.5	158	154.0	25	2.3	34	11.8	0	0.0	0	0.0
34	9	30	1090.0	0.07075	1D	12	3.5	123	123.3	7	0.7	34	13.3	0	0.0	0	0.0
35	10	1	946.5	0.07521	1D	10	3.5	85	84.5	14	0.9	56	17.6	0	0.0	0	0.0
36	10	1	1062.0	0.07901	1D	12	3.5	240	247.2	18	2.8	39	14.1	1	0.2	0	0.0
37	10	1	974.0	0.08596	1D	10	3.4	231	193.6	28	2.0	48	18.0	0	0.0	0	0.0
38	10	1	1170.0	0.08083	1D	12	3.5	200	192.9	11	0.8	27	10.3	1	0.2	0	0.0
39	10	1	1348.0	0.08286	1D	14	3.4	175	200.8	4	1.2	20	8.3	0	0.0	0	0.0
40	10	2	1380.5	0.08246	1D	14	3.3	50	65.5	33	13.7	13	4.5	0	0.0	0	0.0
41	10	2	1478.0	0.06232	1D	15	3.1	81	104.8	45	18.3	15	8.6	1	0.1	0	0.0
42	10	2	1351.5	0.06984	1D	14	3.3	76	149.2	57	20.2	14	13.8	0	0.0	0	0.0
43	10	2	1494.5	0.07790	1D	15	3.2	18	48.0	64	27.6	10	5.4	0	0.0	0	0.0
44	10	3	1272.0	0.06950	1D	14	3.3	163	222.7	30	11.2	9	9.7	0	0.0	0	0.0
45	10	3	1188.0	0.07075	1D	12	3.4	117	162.3	4	0.8	4	3.4	0	0.0	0	0.0
46	10	3	1291.5	0.07752	1D	14	3.1	94	202.4	28	10.9	7	6.0	0	0.0	0	0.0
47	10	4	1143.5	0.06813	1D	12	3.6	124	158.1	30	4.5	5	1.7	0	0.0	0	0.0
48	10	4	1140.5	0.07111	1D	12	3.6	334	389.9	457	38.0	19	13.9	0	0.0	0	0.0
49	10	4	1292.0	0.08821	1D	14	3.2	714	921.1	2342	282.7	36	17.4	0	0.0	0	0.0
50	10	5	518.5	0.06614	1D	6	5.3	3	2.9	107	11.5	8	0.5	267	36.2	23	2.3
51	10	5	1330.5	0.07484	1D	14	3.3	27	64.2	74	12.8	15	8.5	0	0.0	0	0.0
53	10	6	1150.5	0.07558	1D	12	3.6	92	113.2	50	9.2	14	7.8	0	0.0	0	0.0
55	10	7	1320.0	0.07752	1D	14	3.4	51	107.6	56	19.3	8	5.0	0	0.0	0	0.0
56	10	5	1136.5	0.07116	1D	12	3.6	118	147.0	78	14.9	12	8.9	0	0.0	0	0.0
57	10	5	1116.0	0.06847	1D	12	3.6	108	140.6	123	13.8	6	2.5	0	0.0	0	0.0
58	10	5	1093.0	0.07190	1D	12	3.6	80	109.5	59	7.9	12	3.2	0	0.0	0	0.0

Table 3. Biomass (tons) of Greenland halibut by division and depth stratum, 1998

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	4	0.0756	254.4	79.9
	601-800	16120	14	0.3940	6351.6	1152.6
	801-1000	6066	8	1.4073	8536.6	2389.5
	1001-1200	611	2	3.7073	2265.1	139.4
1D	401-600	903	1	0.0438	39.6	.
	601-800	1940	2	0.3845	746.0	76.4
	801-1000	3874	4	1.5193	5885.8	1358.8
	1001-1200	10140	11	2.4032	24368.2	3420.3
	1201-1400	6195	8	2.9822	18474.7	6862.0
	1401-1500	3091	2	1.1489	3551.4	1646.7
ALL				1.3473	70473.5	8391.7

Table 4. Abundance of Greenland halibut by division and depth stratum, 1998.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
1C	401-600	3366	4	122.3	411711.4	131975.7
	601-800	16120	14	660.5	10648016.3	1977394.1
	801-1000	6066	8	1722.4	10448078.3	3003710.1
	1001-1200	611	2	3745.6	2288582.1	205588.1
1D	401-600	903	1	45.4	40961.5	.
	601-800	1940	2	497.0	964268.9	124080.7
	801-1000	3874	4	1696.1	6570850.6	1647525.0
	1001-1200	10140	11	2088.8	21180100.3	3118888.6
	1201-1400	6195	8	2059.5	12758546.2	5559876.6
	1401-1500	3091	2	765.4	2365923.1	1651682.2
ALL				1293.9	67677038.6	7687423.7

Table 5. Mean weight and mean length at age of Greenland halibut in 1997-1995. The otoliths were read by thee different readers in 1995-1996, 1997 and 1998, respectively.

	1998		1997		1996		1995	
AGE	weight	length	weight	length	weight	length	weight	length
1								
2	38.22	18.70	23.33	15.33			50.00	20.00
3	175.50	28.50	58.18	19.82	175.00	30.50	140.00	27.00
4	347.50	35.27	136.96	26.13	378.26	36.35	339.43	35.09
5	551.38	40.94	271.82	32.82	555.56	41.22	495.53	40.13
6	854.15	46.77	443.93	38.04	794.10	45.72	691.59	45.00
7	1218.13	51.94	736.89	43.87	1055.95	49.90	986.56	49.82
8	1572.34	56.81	1070.18	49.85	1447.01	55.34	1360.00	54.51
9	2074.80	60.56	1453.73	55.61	2092.16	61.45	1816.98	59.63
10	2293.45	63.10	2042.90	61.23	2740.63	65.84	2163.50	62.70
11	2866.55	66.48	2814.55	66.68	3241.67	68.43	2679.63	66.30
12	3453.21	69.89	3827.69	72.58	4100.21	72.98	3248.64	69.91
13	4537.50	74.70	4840.00	77.29	4994.00	76.43	4133.57	73.36
14	5112.00	77.60	6679.44	84.00	5946.67	80.56	5685.56	79.78
15	7140.59	85.06	7711.11	87.78	7523.68	86.76	6631.05	83.63
16	8385.00	88.87	9166.00	94.60	8663.04	89.93	7533.00	89.00
17	10684.00	95.40	10796.67	97.83	9208.33	91.94	10413.64	94.64
18					10127.27	95.27	11180.00	97.00
19	12850.00	99.00			11168.18	98.45	11566.67	98.33
20					11100.00	95.00	11326.67	100.33
21					11250.00	98.33	13100.00	103.50
22							13700.00	104.00
24							15300.00	115.00

Table 6. Estimated abundance by age from Div. 1C-1D from the surveys in 1997 and 1998. The Age-length key from 1998 is applied on the 1997 data.

AGE	1997	1998
	Number	Number
2	536130	609093
3	1704893	3722237
4	3023773	4662948
5	9961295	14760362
6	15370847	19057854
7	13558728	14083592
8	5436358	5766084
9	1200931	1515966
10	948950	1211419
11	584382	764751
12	466433	527881
13	187646	351921
14	96503	155657
15	262704	236870
16	187646	115051
17	64336	128586
18	16084	
19		
TOTALS	53613000	67677039
CHECK	53607639	67670271

Table 7. MATURITY (MAT) AT AGE IN PERCENT, FEMALES, WESTGEENLAND 1998.
Maturity:1=immature 2=maturing

	MAT		
	1	2	
	PCTN	PCTN	N
AGE			
3	100.00	.	1.00
5	100.00	.	1.00
6	100.00	.	2.00
7	66.67	33.33	9.00
8	60.00	40.00	20.00
9	23.08	76.92	13.00
10	26.67	73.33	15.00
11	22.22	77.78	18.00
12	14.29	85.71	21.00
13	5.88	94.12	17.00
14	.	100.00	9.00
15	.	100.00	16.00
16	.	100.00	7.00
17	.	100.00	5.00
19	.	100.00	1.00

Table 8. Biomass of (tons) roundnose grenadier by division and depth stratum, 1998.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	4	0.0005	1.5	1.5
	601-800	16120	14	0.0243	391.2	240.1
	801-1000	6066	8	0.1570	952.3	746.0
	1001-1200	611	2	0.0877	53.6	16.4
1D	401-600	903	1	0.1739	157.0	.
	601-800	1940	2	0.0071	13.7	1.6
	801-1000	3874	4	0.0140	54.2	13.0
	1001-1200	10140	11	0.1217	1233.8	474.5
	1201-1400	6195	8	0.5496	3404.6	2356.6
	1401-1500	3091	2	0.3240	1001.4	93.7
ALL				0.1389	7263.3	2530.2

Table 9. Abundance of roundnose grenadier by division and depth stratum, 1998.

	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
	401-600	3366	4	13.6	45649.3	45649.3
	601-800	16120	14	894.0	14410847.1	9715129.6
	801-1000	6066	8	3316.5	20117816.9	14705439.0
	1001-1200	611	2	1469.8	898032.2	94824.9
	401-600	903	1	1617.9	1460959.8	.
	601-800	1940	2	152.6	295962.7	66820.5
	801-1000	3874	4	265.0	1026439.2	152248.3
	1001-1200	10140	11	1097.3	11126689.5	5629429.8
	1201-1400	6195	8	3789.3	23474636.5	20149834.1
	1401-1500	3091	2	771.8	2385763.1	153760.2
				1438.5	75242796.4	27356943.1

Table 10. Biomass (tons) of roughhead grenadier by division and depth stratum, 1998.

	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
	401-600	3366	4	0.0063	21.2	13.2
	601-800	16120	14	0.0367	592.4	166.7
	801-1000	6066	8	0.1007	610.7	117.6
	1001-1200	611	2	0.1369	83.7	5.9
	401-600	903	1	0.0076	6.8	.
	601-800	1940	2	0.1254	243.4	90.2
	801-1000	3874	4	0.1495	579.1	168.2
	1001-1200	10140	11	0.1109	1124.8	195.5
	1201-1400	6195	8	0.1181	731.5	122.7
	1401-1500	3091	2	0.1037	320.4	106.1
				0.0825	4314.1	377.9

Table 11. Abundance of roughhead grenadier by division and depth, 1998

	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
	401-600	3366	4	12.8	42971.6	28792.1
	601-800	16120	14	148.2	2388583.5	577604.5
	801-1000	6066	8	329.3	1997306.2	283087.2
	1001-1200	611	2	398.9	243748.9	18350.3
	401-600	903	1	121.0	109230.6	.
	601-800	1940	2	442.9	859258.1	133691.7
	801-1000	3874	4	438.4	1698278.8	505922.1
	1001-1200	10140	11	249.3	2527496.5	497029.6
	1201-1400	6195	8	191.4	1185592.3	223053.1
	1401-1500	3091	2	184.5	570400.7	173600.2
				222.26	11622867.3	1007814.4

Table 12. Biomass (tons) of *Sebastes mentella* by division and depth stratum, 1998.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	4	0.2692	906.1	203.3
	601-800	16120	14	0.0555	894.1	456.5
	801-1000	6066	8	0.0010	6.1	4.1
	1001-1200	611	2	0.0000	0.0	0.0
1D	401-600	903	1	0.5474	494.3	.
	601-800	1940	2	0.0518	100.5	64.8
	801-1000	3874	4	0.0000	0.0	0.0
	1001-1200	10140	11	0.0005	4.6	3.1
	1201-1400	6195	8	0.0000	0.0	0.0
	1401-1500	3091	2	0.0008	2.5	2.5
ALL				0.0460	2408.1	503.9

Table 13. Abundance of *Sebastes mentella* by division and depth stratum, 1998.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
1C	401-600	3366	4	2369.4	7975448.7	2676104.9
	601-800	16120	14	415.3	6694613.4	3601133.8
	801-1000	6066	8	4.0	24047.2	15759.9
	1001-1200	611	2	0.0	0.0	0.0
1D	401-600	903	1	4037.3	3645669.4	.
	601-800	1940	2	226.4	439164.0	286402.4
	801-1000	3874	4	0.0	0.0	0.0
	1001-1200	10140	11	2.3	23072.8	15478.9
	1201-1400	6195	8	0.0	0.0	0.0
	1401-1500	3091	2	8.0	24800.0	24800.0
ALL				165.9	18826815.5	4495868.3

Table 14. Biomass (tons) of American plaice by division and depth stratum, 1998.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	4	0.0239	80.3	53.3
	601-800	16120	14	0.0015	24.8	17.2
	801-1000	6066	8	0.0000	0.0	0.0
	1001-1200	611	2	0.0000	0.0	0.0
1D	401-600	903	1	0.0348	31.4	.
	601-800	1940	2	0.0000	0.0	0.0
	801-1000	3874	4	0.0000	0.0	0.0
	1001-1200	10140	11	0.0000	0.0	0.0
	1201-1400	6195	8	0.0000	0.0	0.0
	1401-1500	3091	2	0.0000	0.0	0.0
ALL				0.0026	136.5	56.0

Table 15. Abundance of American plaice by division and depth stratum, 1998.

.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
	401-600	3366	4	239.3	805455.7	625742.9
	601-800	16120	14	10.0	160943.3	100382.4
	801-1000	6066	8	0.0	0.0	0.0
	1001-1200	611	2	0.0	0.0	0.0
	401-600	903	1	347.8	314038.1	.
	601-800	1940	2	0.0	0.0	0.0
	801-1000	3874	4	0.0	0.0	0.0
	1001-1200	10140	11	0.0	0.0	0.0
	1201-1400	6195	8	0.0	0.0	0.0
	1401-1500	3091	2	0.0	0.0	0.0
				17.2	1280437.1	633743.5

Table 16. Mean temperature, S.E and number of observations by NAFO Division and depth stratum.

Div.	Depth stratum (m)																	
	401-600			601-800			801-1000			1001-1200			1201-1400			1401-1500		
	°C	SE	n	°C	SE	n	°C	SE	n	°C	SE	n	°C	SE	n	°C	SE	n
1C	5.0	.11	4	3.6	.21	14	3.8	.05	8	3.5	0	2						
1D	5.3	.	1	3.8	.05	2	3.5	.03	4	3.5	.02	11	3.3	.04	8	3.2	.05	2

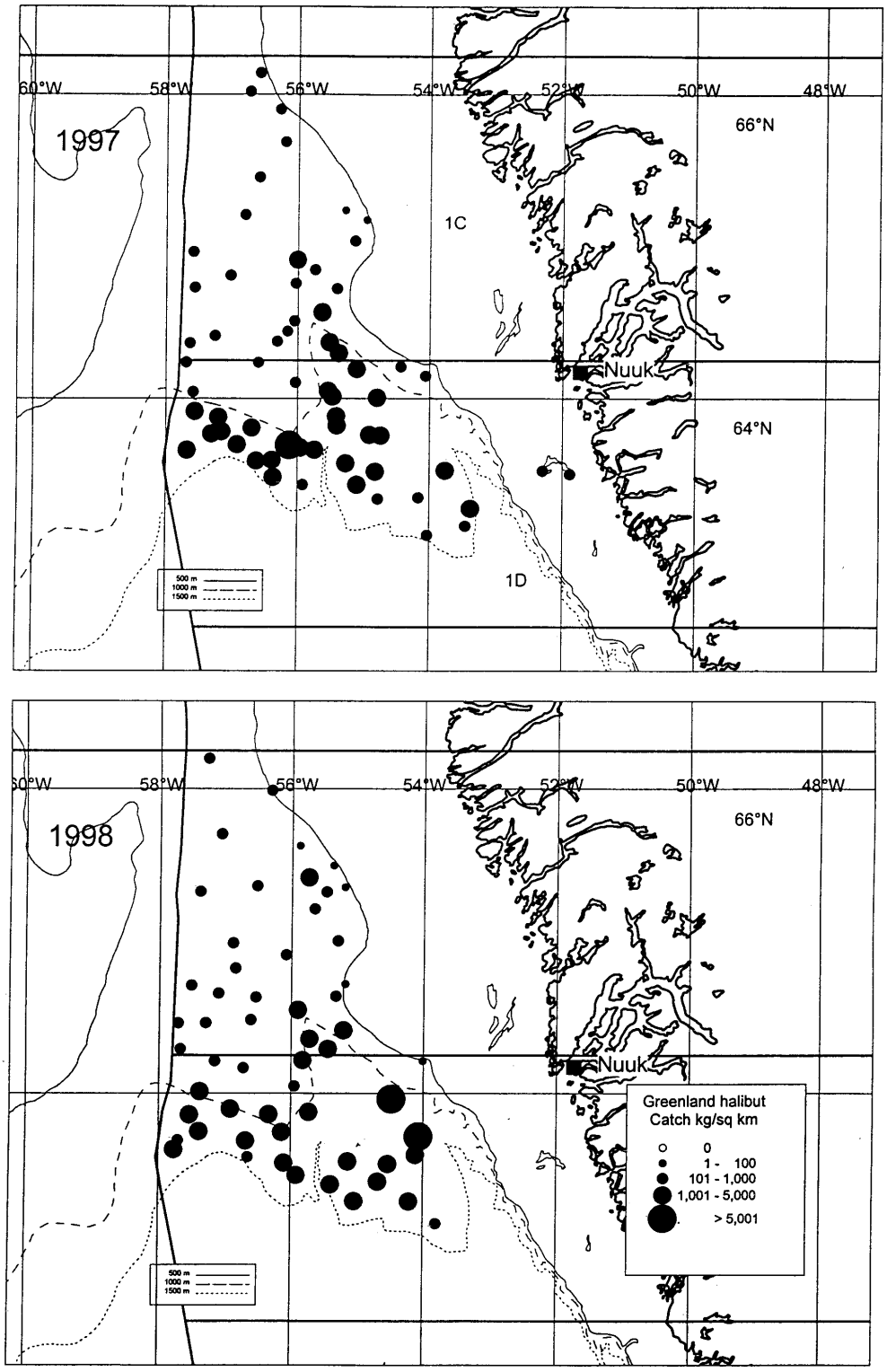

Fig. 1. Distribution of catches of Greenland halibut in 1997 and 1998.

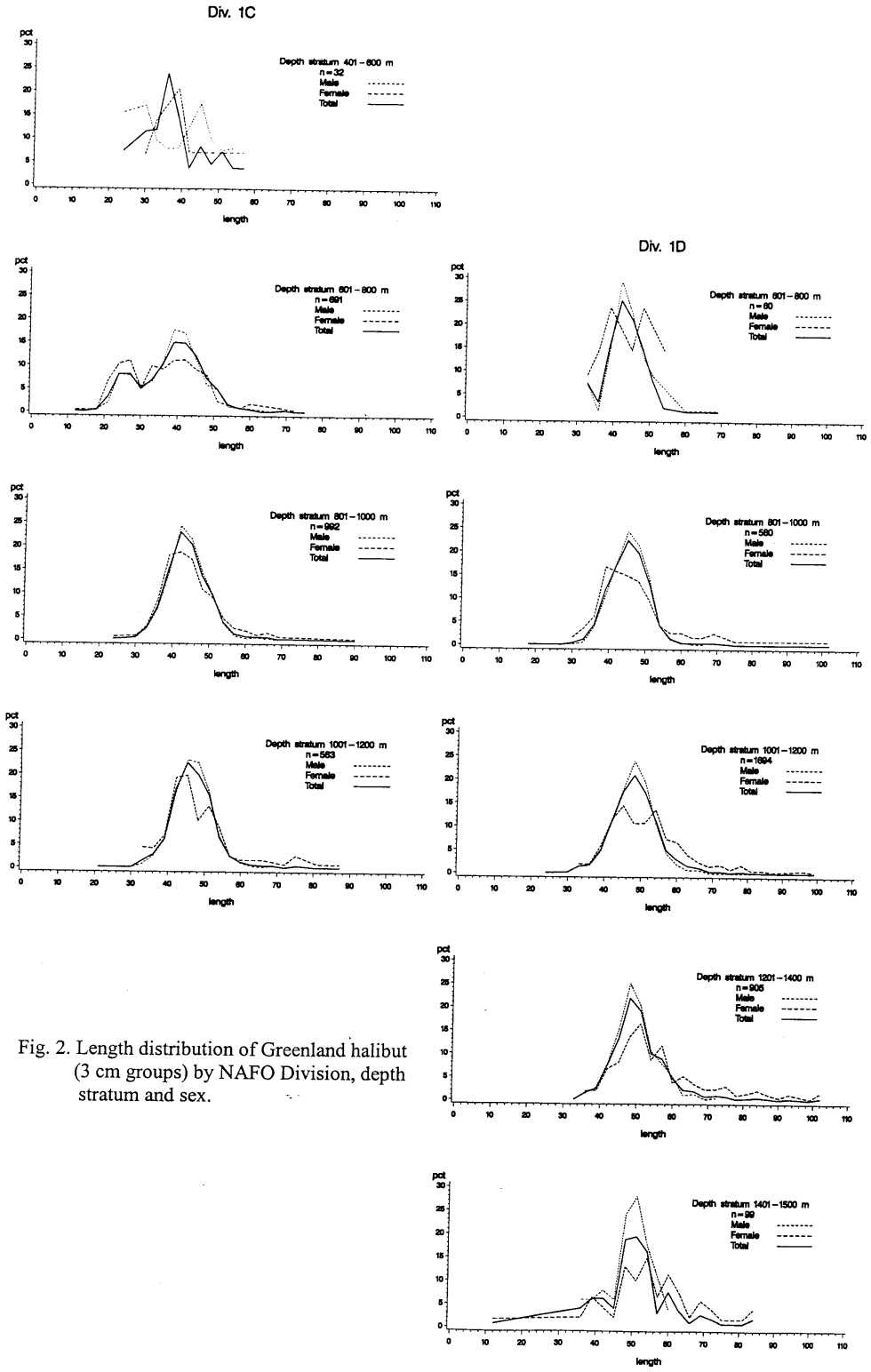

Fig. 2. Length distribution of Greenland halibut (3 cm groups) by NAFO Division, depth stratum and sex.

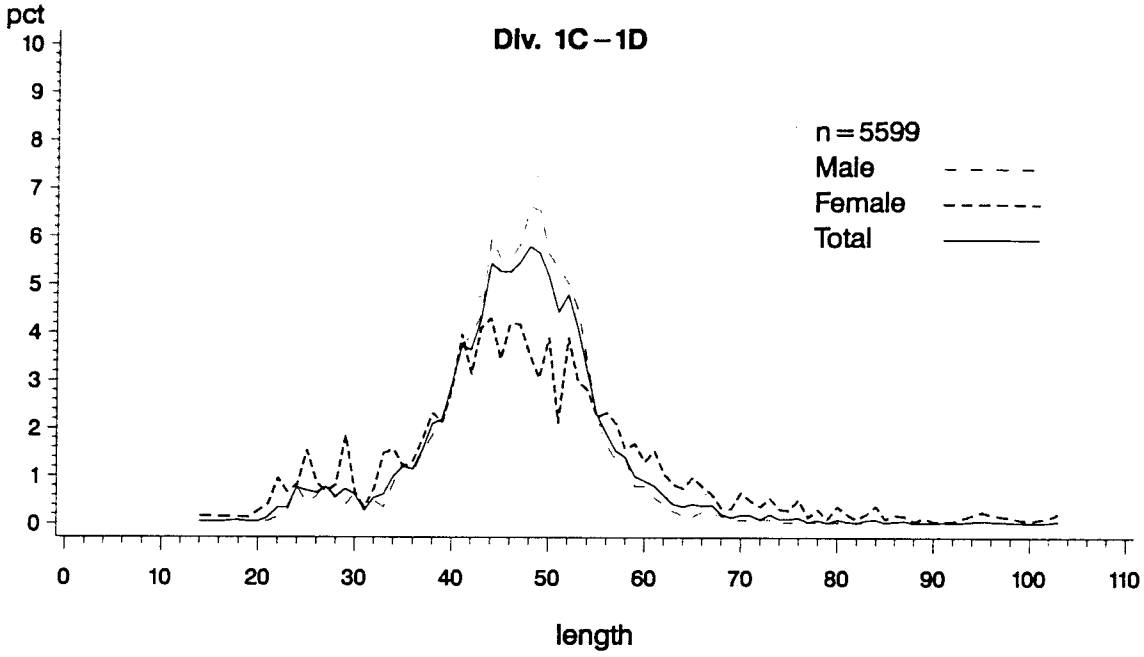

Fig. 3. Overall length distribution (weighted by stratum area) of Greenland halibut.

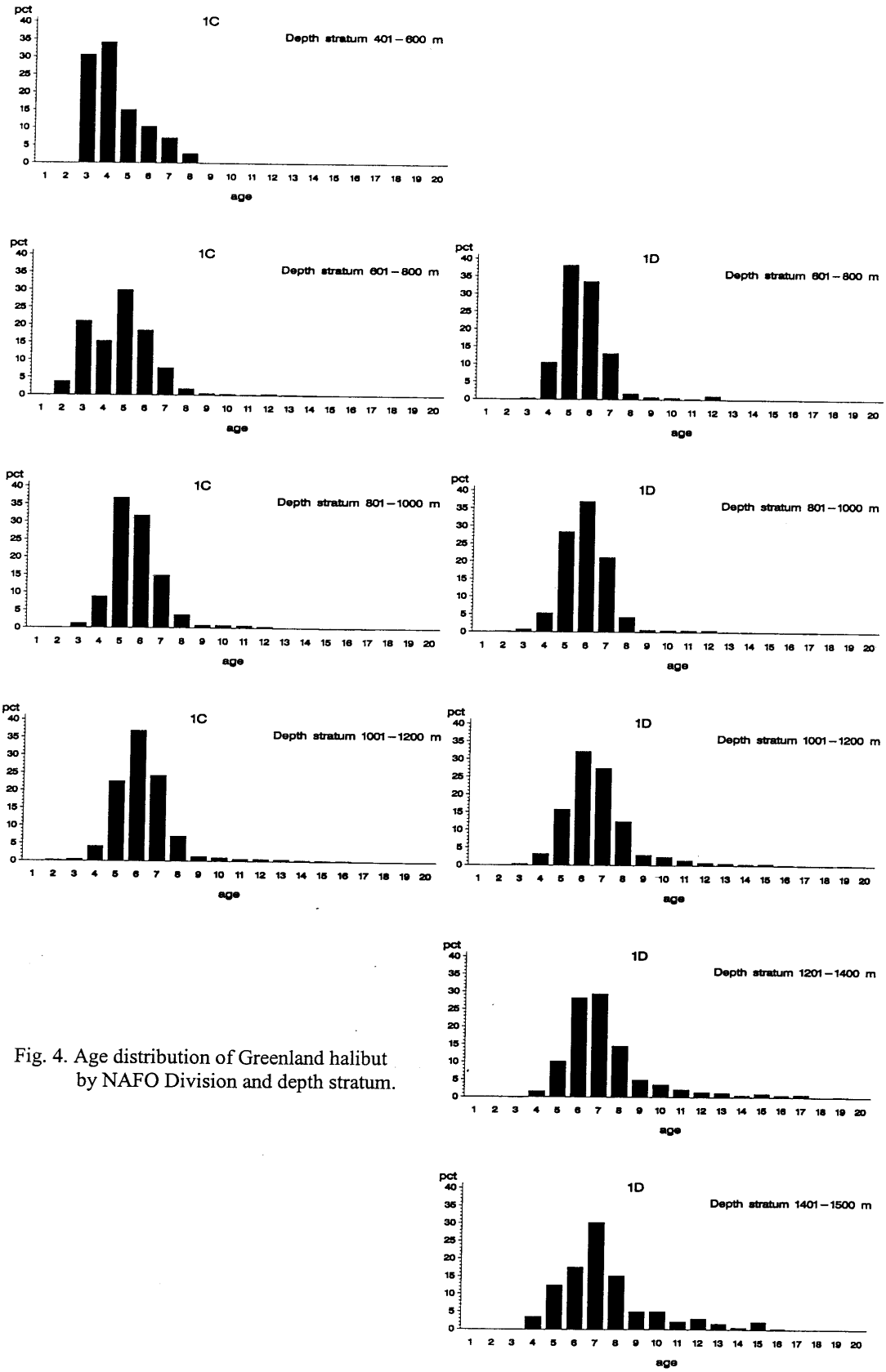

Fig. 4. Age distribution of Greenland halibut by NAFO Division and depth stratum.

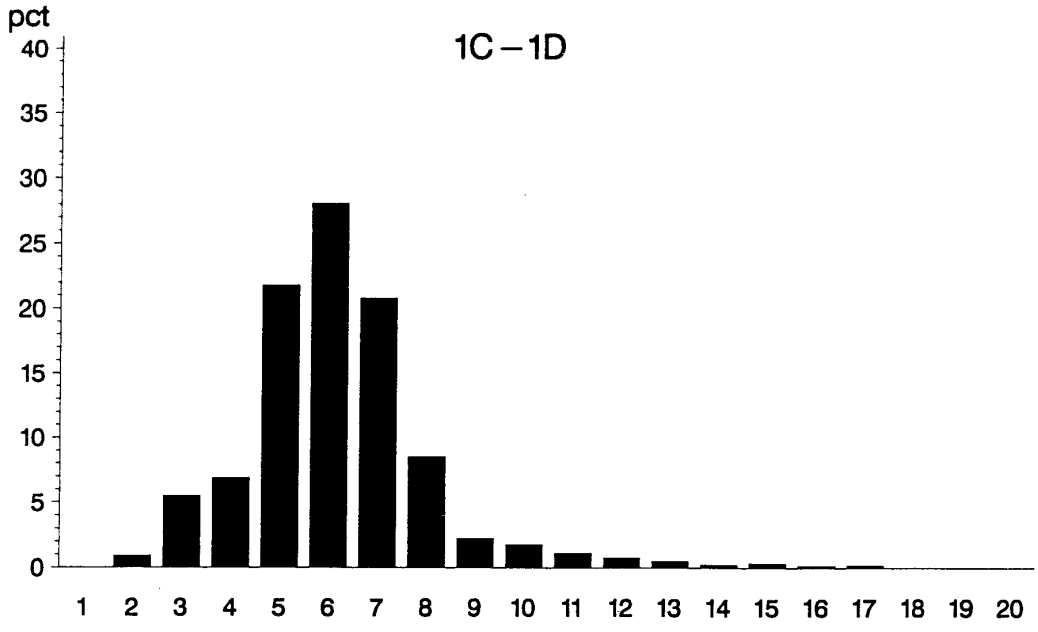

Fig. 5. Overall age distribution (weighted by stratum area) of Greenland halibut in 1998.

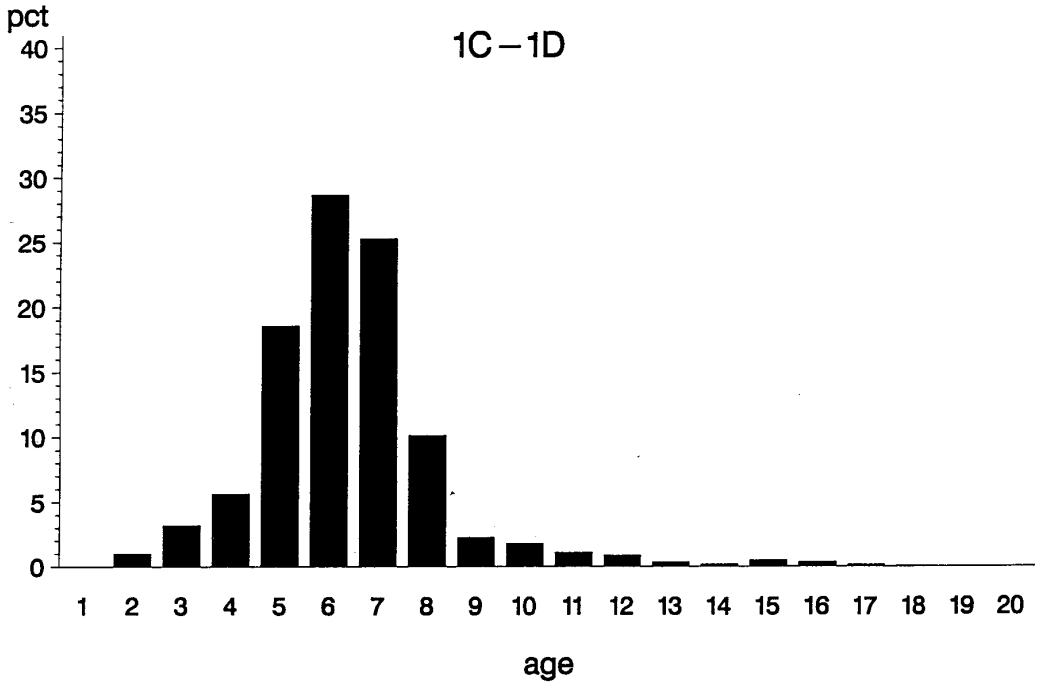

Fig. 6. Overall age distribution (weighted by stratum area) of Greenland halibut in 1997.

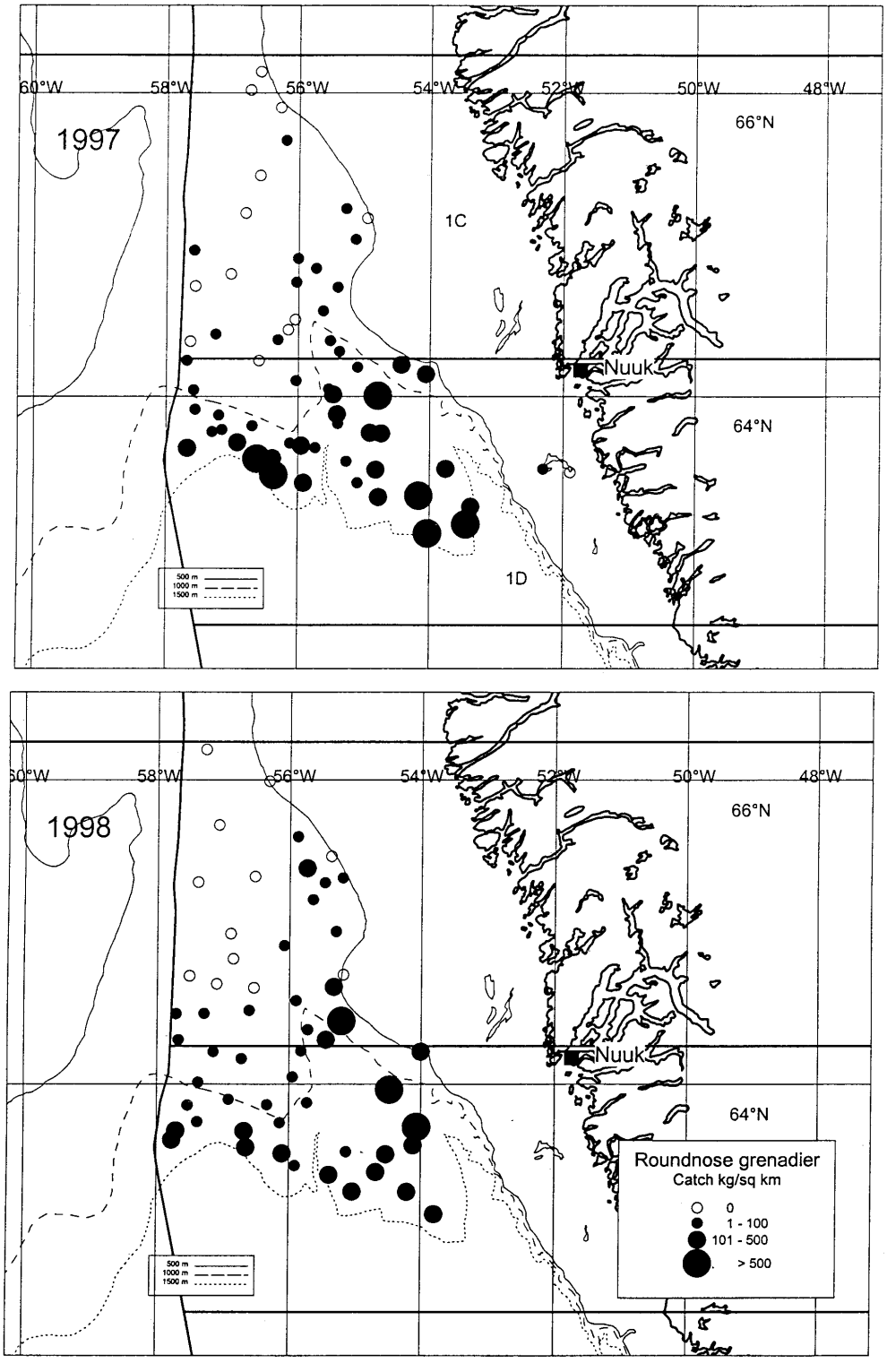

Fig. 7. Distribution of catches of roundnose grenadier in 1997 and 1998.

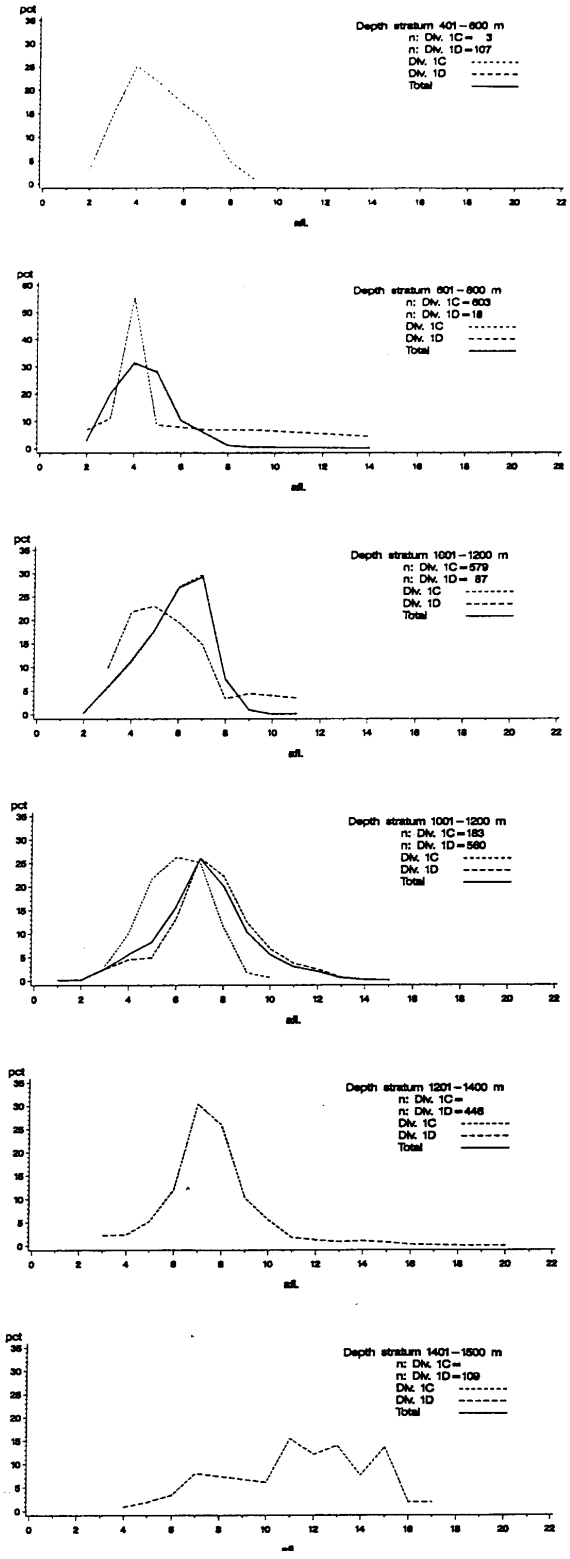

Fig. 8. Length distribution (pre anal fin length) of roundnose grenadier by depth strata. (Third panel from top should be 801-1000 m).

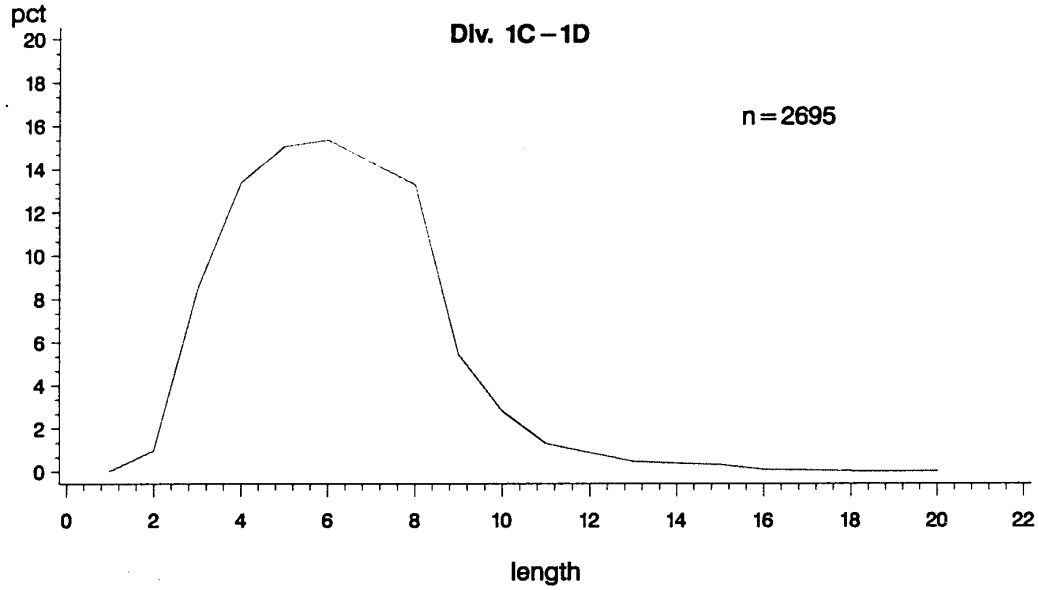

Fig. 9. Overall length distribution (per anal fin length) (weighted by stratum area) of roundnose grenadier.

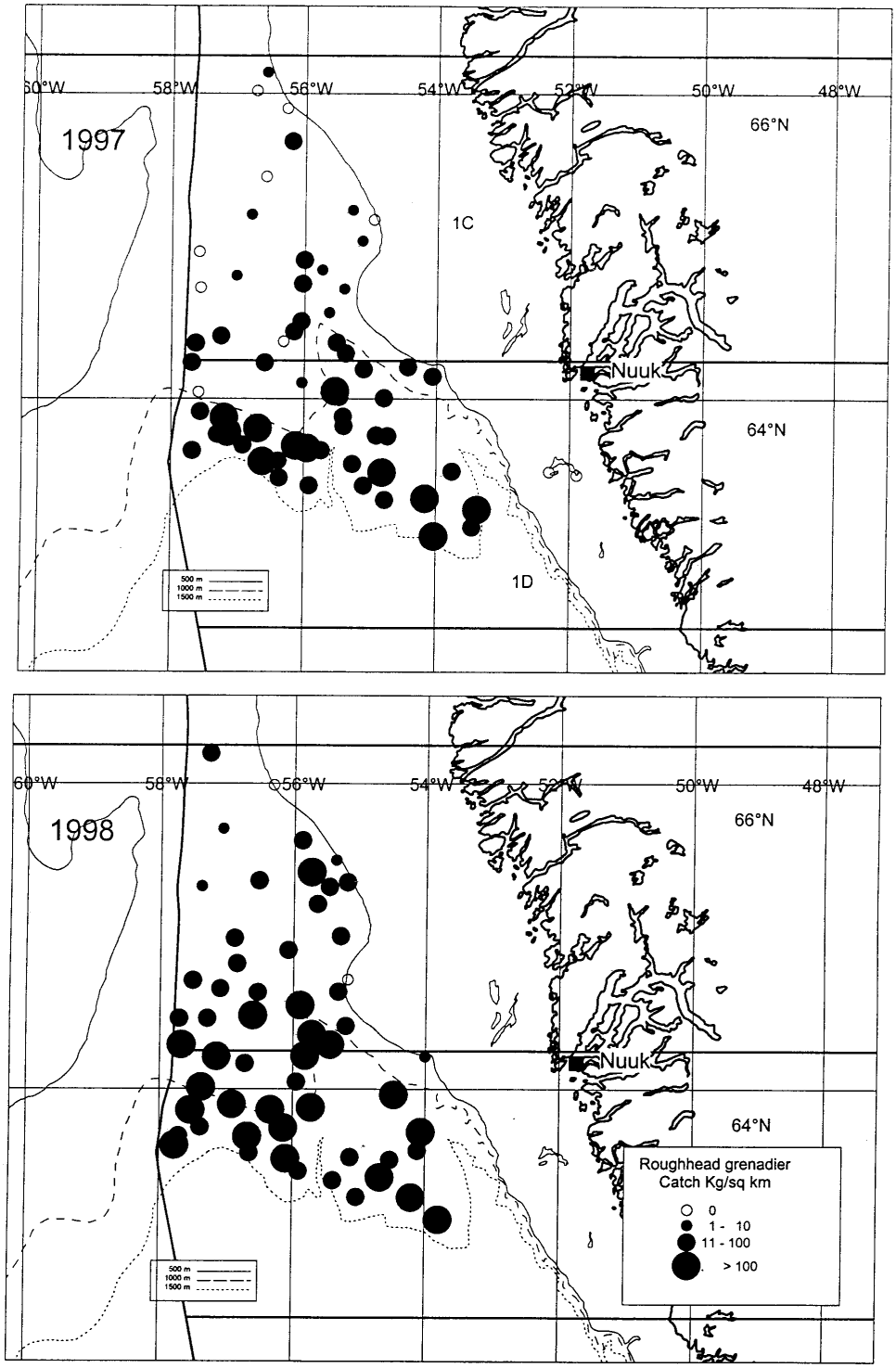

Fig. 10. Distribution of catches of roughhead grenadier in 1997 and 1998.

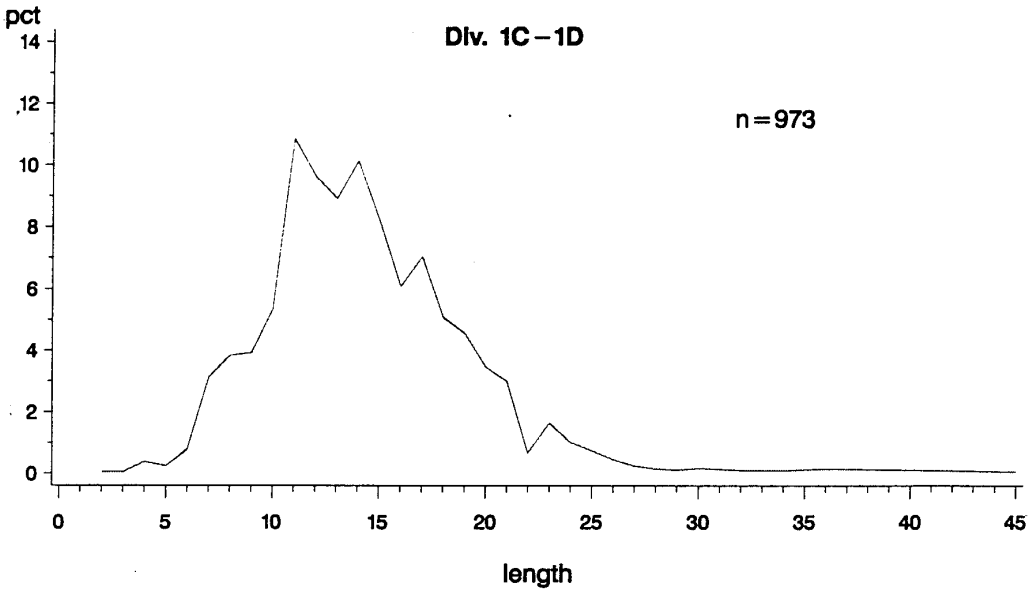

Fig. 11. Overall length distribution (pre anal fin length) (weighted by stratum area) of roughhead grenadier.

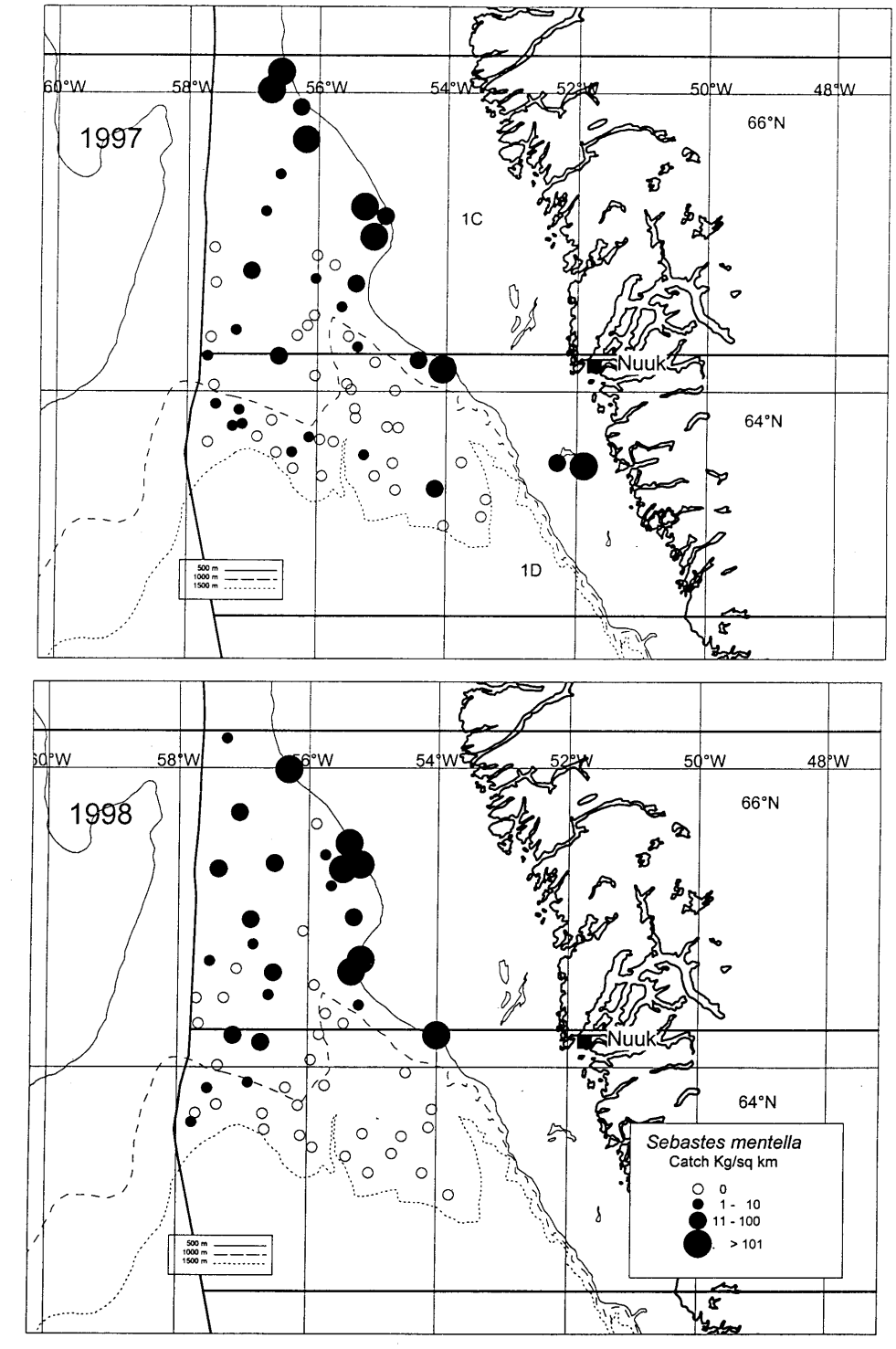

Fig. 12. Distribution of catches of *Sebastes mentella* in 1997 and 1998.

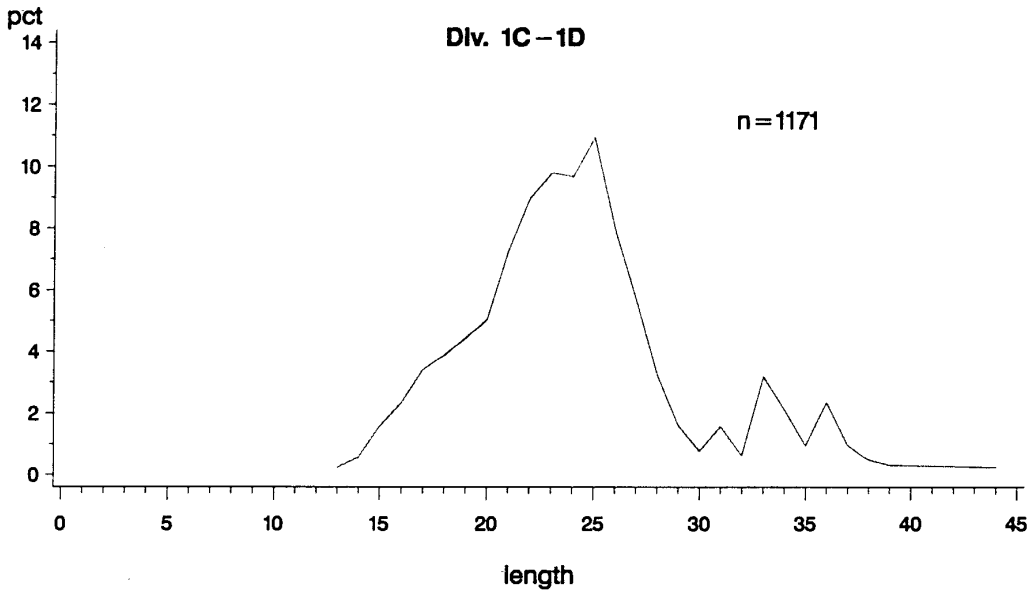

Fig. 13. Overall length distribution (weighted by stratum area) of *Sebastes mentella*.